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VIRTUAL REALITY ANALYSIS

Development of Virtual Reality Application with Unity 3D

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ABSTRACT

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The aim of this thesis was to bring bigger exposure to the latest computer science technology such as Virtual Reality. Computer technology has transformed this world into the digital world. Every day new ideas and technologies are being developed and one of them which is growing tremendously is Virtual Reality. This thesis has been presented to acknowledge readers about the positive and negative impact of Virtual Reality. The thesis has concluded every related information that is important for any reader who wants to understand about Virtual Reality.

The thesis also gives technical information about developing a VR application with the use of a machine-based environment called Unity 3D. The development process of a simple VR application is cited in a very simple and easy way for a developer who wishes to develop a VR application. The integration of hardware and software has been clarified with illustrative images and block diagrams. Hence thesis has been a complete resource for any reader who wishes to emphasize their ideas about Virtual Reality.

Key words
Augmented Reality, Extended Reality, Mixed Reality, Multi-dimensional, Virtual Reality

CONCEPT DEFINITIONS

List of Abbreviations

3D	Three Dimensional
3DOF	Three Degrees of Freedom
6DOF	Six Degrees of Freedom
AR	Augmented Reality
CAGR	Compound Annual Growth Rate
EMG	Electromyography
HMD	Head Mounted Display
HTC	High Tech Computer Corporation
Immersion	Act of putting someone or something into something
LCD	Liquid Crystal Display
MR	Mixed Reality
Simulation	Production of a computer model
SDK	Software Development Kit
USD	United States Dollar
VR	Virtual Reality
XR	Extended Reality

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1 INTRODUCTION

This is an era of science and technology. Invention, discovery, and research has been the major interest of everyone. Every second something spectacular is being invented or created in the name of science and technology in a corner of the world and it is unstoppable. These inventions and discoveries are considered as an accomplishment. From Abacus to Supercomputer the world has changed significantly. Now the Artificial Intelligence and Virtual Reality has set to roll all over the world. Virtual Reality is a technology that would make people believe something which is not real. The clear image of the future world which is rolled up in Virtual Reality can be imagined in a few years of time. This technology is ready to break the definition of reality. Any imagination of a human mind is becoming possible to experience in the real world with the help of Virtual Reality.

Virtual Reality is sure to become a major technology in the future based on the present scenario of its development. This thesis aims to provide all the brief information on Virtual Reality in the past, present, and future. The thesis will not only include the positive factors of this technology, but it will also include the negative factors which are severely affecting human life. While focusing on advanced technology, the consciousness of what humanity really means is being lost.

The last part of the thesis will contain some technical work of developing a Virtual Reality application. This thesis is a package of practical and theoretical information about Virtual Reality. The technical work is about developing a simple application that can be implemented in Virtual Reality devices.

2 VIRTUAL REALITY AND OTHER REALITIES ASSOCIATED WITH IT

It has been taught in school that human beings have five sense organs to taste, feel, smell, hear and see the world around us. The computer technology provides the same sensation of things that don't exist in real at the same time using different technology and program to the user with the help of Virtual Reality. Everything known or felt is information carried out by the sensory organs of a body to the brain. Virtual Reality works in the principle, that artificially created information is carried out by the sensory organ using different computing programs that provide a sensation of reality to some extent.

The term Virtual Reality is composed of two different words 'Virtual' and 'Reality', where computing definition of virtual means not physically as such but provides a sensation of physical dimensions using computer programs and reality is what is experienced with the sense organs. So Virtual Reality is a computing skill that can provide the sensation of the reality of any virtually created environment. Technically, Virtual Reality is a three-dimensional 3D, computer-generated environment which can be experienced and interacted by a person with the help of physical devices such as headset and gloves. (Bardi, 2019.)

Similarly, according to the Cambridge Dictionary meaning, Augment means 'to add or increase the value of something by adding something' to it. (Cambridge University Press, 2019) So Augmented Reality is a computer technology that generates the new digital environment adding something to the object that resides in the real world. Augmented reality enhances the real object of the real world using different AR cameras of the smartphone or by adding computer vision and provides the sensation of a new environment with enhanced audio, video or image to the user. Pokémon Go and Snapchat filters are a popular example of Augmented Reality. While Virtual Reality provides an entirely new experience of virtual world Augmented Reality emphasizes the real world adding something to it. (Rouse, 2016.)

Mixed Reality is the combination of Virtual Reality and Augmented Reality to provide not just an experience of a virtual environment but also provide interaction between the virtual object and the user. Mixed Reality makes the possibility of interaction between the physical and digital world. (Rogers, 2018.)

Extended Reality is the umbrella term used for different kinds of technology that may happen in the future that are similar more advance than Augmented Reality and Virtual Reality. XR covers all those full spectra of Real and Virtual Environments. (Marr, 2019.)

3 HISTORY

It is hard to find out the exact date when the idea of Virtual Reality arises in the human mind, but today's Virtual Reality is born from a very old concept. The panoramic paintings of the 18th century can give a glance of Virtual Reality that exists now. In the 1800s the inventor of kaleidoscope developed a stereoscope using lenses that could give a 3D view of images. Brewster's design of stereoscope at that time has the same concept as of today's google cardboard. Generally, Virtual Reality means, a VR headset or different computer applications that support VR which is implemented based on the imagination that people have had for centuries. In 1930 Stanley G. Weinbaum had explained a goggle-based game that can watch a holographic recording of a virtual story in Pygmalion's Spectacles. In this chapter, the extensive history of Virtual Reality from the nineteenth to the twentieth century elucidated. (Jerald, 2016.)

3.1 Virtual Reality in the 20th Century

The term Virtual Reality is widely used around the mid-1980s when different kinds of technology such as gloves, gear, and goggles to experience Virtual Reality were being developed. However, before that also there were many technologists that were developing a simulated environment. Among them, Sensorama in 1956 was a big achievement in the field of Virtual Reality when Morton Heilig wanted to see how people feel to experience his movie in real. The Sensorama simulated a real city experience riding a bike using different multisensory stimulation. He also designed the first head-mounted display device which is the foundation for gears that are being developed now. In 1965 A computer scientist Ivan Sutherland developed a modern head-mounted device that owes a debt of gratitude from the present developers of Virtual Reality. (Dormehl, 2017.)

"The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming, such a display could literally be the Wonderland into which Alice walked." (Sutherland, 1965).

Later after three years in 1968 Sutherland with his student Bob Sproull, invented the first Virtual Reality Head Mounted Display (HMD) called The Sword Of Damocles. The devices were connected to a

computer and were only developed for lab projects as it was too heavy for the users. Despite all this development, there was no exact term coined to describe the field. In 1987 Jaron Lanier founded a Visual Programming Lab and coined the term Virtual Reality. The access of Virtual Reality devices began after 1990 when Virtuality Groupe launched several arcade games and machines where the user can play different games with real-time using different VR goggles. The consumer electronics show in 1993 Sega announced a VR headset that had head tracking, stereo sound and LCD screen in the visor. However, the invention was a huge flop. When Wachowski siblings' film 'The Matrix' in 1999 based on simulated reality hits the theatre, it brought major attention of people on the topic of simulated reality. (Dormehl, 2017.)

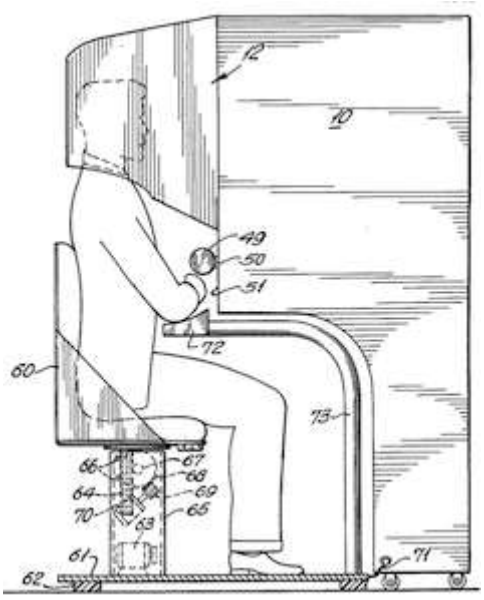


Figure 1: VR device in the 20th century (Dormehl, 2017).

3.2 Virtual Reality in the 21st century

Virtual Reality in the twenty-first century is growing at a rapid speed. The availability of cheap smartphones has helped in the advance development of cheap and portable Virtual Reality devices. The companies like Google, Facebook, Samsung are working on Virtual Reality. Microsoft, Sony, HTC are also working to bring their technology with Virtual Reality applications.

The first decade of the 21st century is known as VR winter. There was not so much media attention until companies like Oculus or HTC started providing personal VR headset, but the technology has already taken its pace since the beginning of the 21st century. For the development of VR when Facebook bought

Oculus in 2014 for 2 billion dollars, the new era of VR was born. Meanwhile, VR has succeeded to become an integral part of different sectors such as education, entertainment, movies and games (Jerald, 2016.)

Since the major product of VR is a headset, many companies are developing different kinds of VR headset. Modern headset now can be categorized into three types mobile, tethered or standalone. Mobile headsets use smartphones to turn it into a VR device. These headset does not require any extra cables and relatively cheaper. Samsung Gear VR and Google Daydream are popular mobile VR at the present time. Though they can provide VR experience mobile headset are failed to provide a full experience of 6 DOF. Likewise, tethered devices like the Oculus Rift S, HTC Vive, and the PlayStation VR are connected to the PC with the help of cable which can give you a complete VR experience. Since these are connected to the pc these are not potable as mobile VR. These are comparatively expensive than a mobile headset. Standalone VR headset is independent do external device is but limited to provide a compete for VR experience as mobile VR. They don't rely on any flagship phone or any gaming PC. Oculus Go and Lenovo Mirage Solo were considered useful to provide their own taste of VR. (Greenwald, 2019.)

Picture 1: Oculus headset for sale in Amazon. (amazon, 2019)

4 COMPONENTS OF VIRTUAL REALITY

The basic component of every computer technology is hardware and software. Virtual Reality is also composed of hardware and software like any other computing device. Hardware is the physical component used for the different functioning of computer technology. In Virtual Reality, this hardware is used to produce stimuli that override the sense of the user. VR devices consist of input and output devices and sensors which helps in the interaction between physical devices and users. The computer is used to process input and output serially. PC, Smartphones, Consoles are important components of Virtual Reality. (Bamodu & Ye, 2013.)

VR interaction is designed to immerse the user into the virtual world to provide a sensation of reality as much as possible. The complete immersion into a virtual world requires excellent coordination of physical body movements, input data, processing units, and other hardware and sensors. Since, VR engine can input data from various sources such as body gesture, speech, sight the proper co-ordination between different components is vital. (Jerald, 2016.)

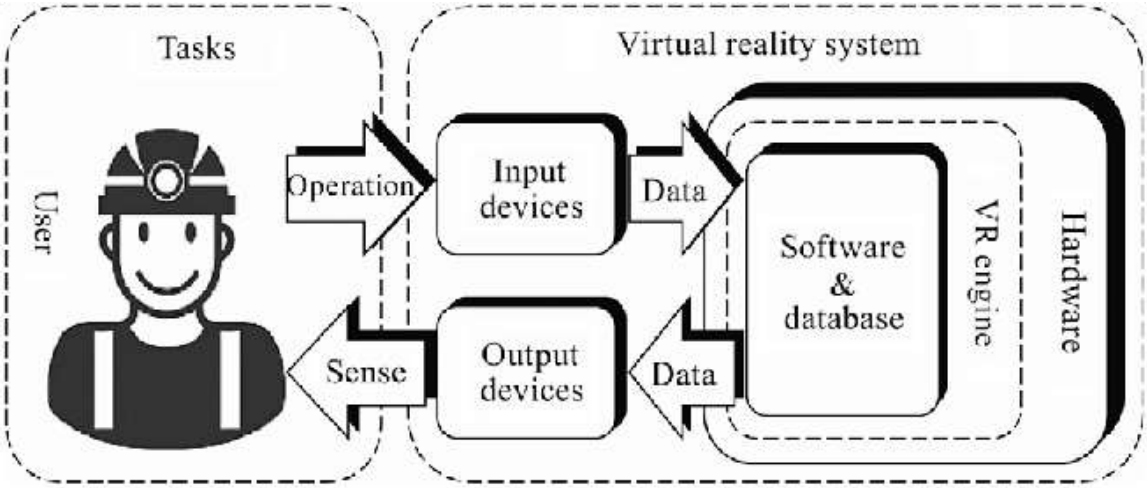


Figure 2: Component of Virtual Reality (Zhang, 2017).

4.1 Input Devices

The physical devices that are used to input data or information in the computer technology are called Input device. Input devices in VR are used to provide a sense of immersion. In Virtual Reality, various

things are used for the immersion of senses. The input devices in this technology are not just confined with the physical devices but different parts of human bodies and activities such as eyesight, sound, breathing rhythm, heartbeat are used as a medium to input senses. With the help of input devices, a user can navigate and guide himself in the virtual world. Input devices are directly related to the sensors. In many cases sensor itself work as an input device to acquire information from the sight or movement of a user. Input devices used in Virtual Reality can be categorized based on size and shape. (Bamodu & Ye, 2013.)

Picture 2: Input devices from HTC and Oculus (VRroom, 2016).

VR has not completely got out of the ground yet though to make it more lifelike many companies have been working to take off the ground and make it move in the free world. The non-portable VR input devices which are fixed in-ground are called Grounded input device. These are not considered very ideal for VR. These are used in the entertainment industry where the user goes for VR gaming experience, for example, Disney Aladdin ride. The treadmill is an example of this kind of input device. (Naimark, 2018.)

4.1.1 Handheld Controllers

In the present time as many companies enter the VR headset game, there is a rapid advancement in the technology of input devices. Many grounded huge devices are being replaced by small and portable devices. The joystick is a gaming tool to play games on the computer. Since a big part of VR is being developed by gaming Companies Joystick is used as an input device in it. Virtual Reality is moving in the free world and the use of joystick is slowly being replaced by free-roaming devices. (Shanklin, 2016.)

DOF stands for the degree of freedom. In Virtual Reality, DOF is used to track the axes. 3DOF means orientation tracking. 3-DOF allows a user only a rotational motion to the user but not the translational movement. Therefore, a user with 3-DOF can track whether left or right, up and down. 3-DOF mostly use inbuilt sensors like accelerometers, gyroscopes, and magnetometers in devices like a smartphone to measure movement. It basically helps in watching 360-degree videos or images like viewing the interior of a building. (Weis, 2018.)

The degree of freedom is essential in VR technology as it relates to the movement of an object in the virtual world. Any interaction between user and object happens in six ways three directional axes and three rotational axes and this movement in axes are called the degree of freedom, DOF. 6-DOF allows a user to track both translational and rotational movements forward or backward, laterally or vertically, Up or down. These provide a more realistic view of the user. (Weis, 2018.)

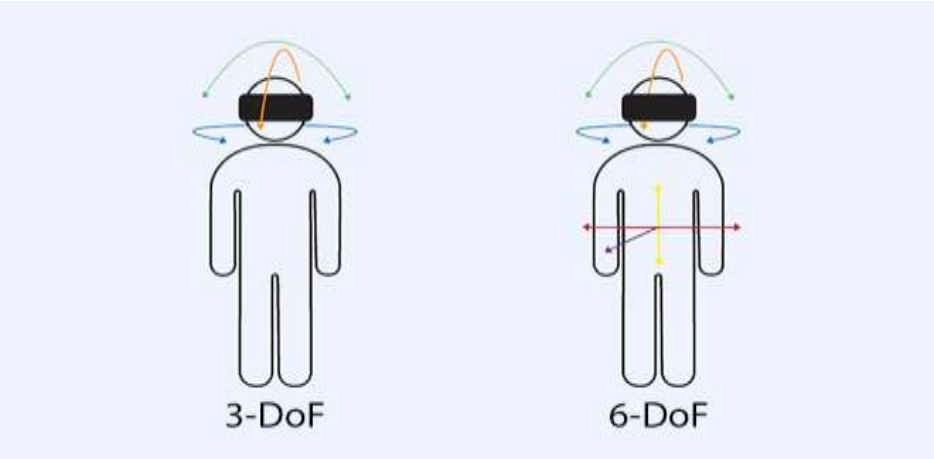


Figure 3: Image showing the difference between 3-DoF (rotational movement) and 6-DoF (rotational and translational movement) with a VR headset. (Barnard, 2019).

Virtual Reality headset uses a different VR lens and cameras that use the sight of humans to perceive information and stimuli the lens to provide a vision. The optical system in Virtual Reality is designed in such a way that different parts of the human body such as eyes or hands are used as a source to input information using different cameras and AR/VR lenses. This optical system helps in the functioning of body tracking or motion capture. (Naimark, 2018.)

4.1.2 Hand Worn Devices

Hand worn devices are devices that are possible to wear in the user's hands to input information such as gloves, EMG sensors, and rings. These gloves are designed not only to pass the information but also are capable to feel the object created in the virtual world. These give the real sensation of feeling an object to the brain. It’s not just about tracking the user's hand but can react with the object in a virtual environment in real-time. (Naimark, 2018.)

Picture 3: User with VR gloves (Thomas, 2018).

4.2 Output Devices

Every computing technology has an output device to show the result digitally into different forms like audio or visuals. Basically, output devices used in Virtual Reality are a printer and a video display monitor. In addition, head and ear mounted equipment which relates to input devices to have control in the virtual environment. These are in the developing phase currently as there have not been any devices allow human senses to stimulate in a perfectly ideal manner. Output devices stimulate the sense organs presenting the virtual environment to the user generating an immersive feeling. VR headset is the most used device to experience in the present time as it provides a connection with a very handy smartphone. Big companies like Oculus, Google, HTC Vive, Samsung, Microsoft are producing their VR Headset in huge numbers. (Bamodu & Ye, 2013.)

Picture 4: VR headset (Sherr, 2019).

4.2.1 Visual

The main factor in Virtual Reality is the creation of an artificial environment in a realistic way so that the user can experience a real virtual world. Visual computing is a term used in computer science that handles every visual content used in computer science. 3D models such as computer graphics, machine learning, video processing, human-computer interaction have been possible by visual computing. Machine learning is an interconnection between humans and computers with the use of various interfaces and design. The basic and simple visual creation to create an immersive experience in 360-degree video. More creativity work includes 3D graphics. Computer animation 360-degree videos are limited to just viewing whereas computer animation makes possible the interaction of certain objects in the virtual environment. Usually, the videos are viewed in two dimensions. 3D modeling is the creation of an object in three dimensions using specialized software. The visual effect is a term that describes a manipulated image or enhanced image which cannot be found in the real world. The act of designing a new product to use in visual content is product design. Graphic motion design is an animation with the majority of text as an animated component. (Dauchot, 2018.)

4.2.2 Haptic and Auditory

Audio is comparatively simple to generate in Virtual Reality, but it is equally important to immerse the sensation of reality to the user. Technically auditory representation in the VR system is created by means of a sound system. The technical way of perceiving the sound in VR technology is using devices such

as headphones. Headphones are fixed to the head so that it moves simultaneously with it. It is very important to relate the sound in contrast to the visuals provided in the virtual environment. (Viaud-Delmon, 2014.)

The use of technology to provide that stimulate the sense of touch and motion in a virtual environment is Haptic. This is a powerful technology that has taken a VR to the next level. Haptic is the key component to bring excitement in Virtual Reality. This technology provides a VR user a real sensation of touching and modifying the object in the virtual world. Haptics started as creating vibrations in game controllers and now in the near future, it will be possible to experience any object a user imagines and play with it in the real world. Haptics makes a user possible to experience any texture, temperature, pressure, taste, the smell in the real world. Haptics in VR is usually created in VR gloves, shoes, joystick in which users can receive feedback in the form of vibrations of forces. The feedback can be experienced in a different part of the body. It is also capable to provide a realistic simulation of the movement and behaviors that are like in the real world. It provides a realistic feel of any things inside the virtual environment. For example, a sensation of jumping in moon standing in a room, flying an airplane or any possible imagination human mind can make. (Sherman & Criag, 2019.)

4.3 Audio

Audio is an essential part of Virtual Reality. Audio simply relates to the sound that is generated using different effect as per the need of visual contents. Audio plays a key role in stimuli the sense organ and it is crucial as it contributes to the sense of immersion to the user. The sound system in Virtual Reality has basic audio SDK features spatialization and head tracking which makes origination of sound feels like from a specific desired direction. Audio propagation provides a real-time sound according to the situation. Volumetric sources spread the sound in a definite volume within a given radius which envelops the listener completely. Irrespective of distance the sound is generated that the listener finds it more realistic because of the Near-field rendering feature. (Dougherty, 2017.)

4.4 Software

Software is an integral part of any computer technology. The software can be defined as a computer program or set of instructions that helps a computer to do a specific task to acquire a certain result in

contrast to a related hardware device. The software basically helps in the functioning of any hardware device used in computer technology. As the VR market is expanding rapidly, there are various tools and platforms available to the developers. There are many tools and programming languages to develop Virtual Reality applications, but the most commonly used desktop tools in the present time are Unity 3D and Unreal Engine (Bitner, 2017.)

WebVR tools are also available for developing VR applications in a web browser such as Mozilla Firefox and Google Chrome. WebVR was introduced in 2014 spring for the first time in Mozilla by Vladmir Vukicevic. The tools available in the various browser are struggling with headset devices but are still possible to develop many applications in browsers like Chrome or Firefox. Some of them are Three.js, A-Frame, React VR, Vizor.io and Janus VR (Bitner, 2017.)

WebVR is a JavaScript programming interface (API) that support Virtual Reality device in a web browser. Web tools are generally more simple, quick and easier to develop any VR content compared to desktop tools. It does not require any specific requirements and it is possible to experience VR in the browser. Desktop tools such as unity or unreal are machine-level tools to develop advance VR and personalized content. (Bitner, 2017.)

4.5 Human Perception

The role of a human in VR is not just a user but he is also a component of Virtual Reality. The basic principle of Virtual Reality technology is to immerse into a virtual environment maintaining a balance between them with the help of hardware and software components. Though the beginning of VR happened for entertainment it is no more confined to just entertainment now. The field of Virtual Reality is growing tremendously in a different sector. There are different views of humans regarding Virtual Reality technology. It is important to understand the physiology of the human body to create an optical illusion or to fool the sense organs of humans so that the maximum feeling of reality can be experienced. Human vision provides most of the information to the brain by hearing and feeling. It is important that the system synchronizes all stimuli with users' actions for the proper functioning of the VR system. (Guenard, 2017.)

5 USE-CASES OF VR

The computer has become a boon to present generation to comfort their life and does their work with more accuracy. The technology arising now has gone far beyond just accuracy, reliability or efficiency. The technology such as Virtual Reality, augmented reality and artificial intelligence are breaking down the border between humans and computers. It is crystal clear that in the future computer technology and humans can collaborate on the same platform to assist the human requirements. Computer technology has already become the basic requirement of the present world. There are hardly any sectors untouched by computer technology at the present time. The future of the present world is handed to the technology of Virtual Reality and augmented reality. It is not possible to write in words how much a computer has been helping to assist human life, but it can be predicted how Virtual Reality is going to help in different sectors in the future. (Bambury, 2019.)

5.1 Medical

The life expectancy of the human being is rising along with the use of technology in the medical sector. The presence of modern computer technology in medicine has succeeded to put a high margin in the human life expectancy index. The development of VR in the medical sector is yet to be flourished but it is sure that the use of technology will endlessly benefit in the health sector. Virtual Reality is already ready to bring a revolution in the medical field. The treatment and detection of disease would go far easier beyond human imagination. The health sector is one of the biggest users of Virtual Reality. The learning and research work in the health sector is infinite. It will continue until human remains on the earth. From Diagnosis to Treatment and surgery Virtual Reality has benefitted the health sector in a wide range. (Westwood & Morgan, 2007.)

5.1.1 Medical Learning

One of the biggest advantages of Virtual Reality is that it has made easier for professionals to learn practically about new skills in a safe environment without any risk of causing any danger to a patient. Human simulation software enables medical professionals to interact with each other in an interactive environment. The strategy of learning and teaching has been gradually changing over time. Theory

learning has been more replaced by practical learning. Learning by seeing is more practiced then by reading. Virtual Reality has helped to make the desired materials for learning. The requirement of a real body to study human anatomy can be replaced by the virtual body. The virtual human body which is functioning as a similar real body can be generated and practiced on it without any risk of damaging a real body. A virtual medical lab can be created where different research about health can be performed. Virtual Reality can transport the professionals inside a human body which is otherwise impossible to view and access. Not only the doctors but it would help also a patient to understand about their own disease as they can see and experience their own anatomy. Virtual Reality enhanced the understanding and treatment of a patient with higher satisfaction. (Carfagno, 2019.)

5.1.2 VR For Surgery and Disabled

Surgeries have become an integral part of the medical sector. Most of the diseases are cured by surgeries. Surgeries are a vulnerable and risky task to perform for any doctor. It assists in the safe training of surgeries to the students. Robotic surgery is performed with the help of a robot which is controlled by a surgeon. With the help of Virtual Reality, a surgeon can guide other doctors from anyplace in the world. A virtual robotic surgery is a very delicate procedure as if there is even a small mistake can end the life of a patient. The robotic surgery is a more precise, faster and less risky procedure than a general surgery which results in lesser risk of complications, smaller incision, less blood loss, and faster recovery. (Schreuder, 2014.)

Virtual Reality can provide a chance of experiencing things to physically disabled people that are otherwise impossible to experience. Virtual Reality has become a medium to try out of reach experiences for those who are physically disabled. Virtual Reality can provide an experience of travails and triumphs of climbing mount Everest for those who cannot walk. Virtual Reality can play an important role in healing someone with stroke or sports injury by improving motor skills and helping in muscle recovery. It helps to activate the receptor organ to stimuli on the action done by using VR devices. Virtual Reality can help to create communication between disable and normal people. For example, the deaf can use Virtual Reality devices such as Sign Aloud gloved that would help to translate sign language into audio or text. VR can also assist to provide a vision who has poor eyesight using Near Sighted VR Augmented Aid. VR can give a chance to understand the feeling of a disable people by simulating a real experience through VR to understand what they are going through. (Cahalne, 2017.)

5.2 Education

Modern education requires a modern methodology of learning and teaching. It has been scientifically proved that the human mind can learn quicker and more effectively by experiencing the situation than just reading books. Humans learn by experiencing and interacting with the environment using their senses to derive the information. VR replaces the traditional method of teaching and learning which is based on the only description of a subject. VR provides the student to experience a subject that would be difficult to explain with just text and descriptions. VR allows the teacher to have a practical teaching environment which a student can experience and experience themselves to have a better understanding of that subject. Virtua Reality is broadly applicable in different sectors of education such as sciences, archeology, history, and architecture. Virtual Reality provides a more engaging and constructive environment for learning. (Christou, 2010.)

5.2.1 Global Teleportation

One of the biggest advantages of Virtual Reality in education is it breaks down the geographical barrier of distance for learning. A student can visit a classroom or research center anywhere in the globe. The students of Africa can attend and participate in the virtual classroom created in Europe. It is not just about the presence and having access, but also interaction with the students and teachers in real-time is possible. Virtual classroom and practice lab can be created and can be accessed throughout the globe by anyone. Virtual Reality would provide a time machine effect. A student can literally travel in time and experience the past to understand history. The student can experience Greek civilization or climb the pyramid of Egypt. It would be possible to have a pyramid in the classroom and study it, making it a more contextualized learning. (Bambury, 2019.)

5.2.2 VR in School and Training

VR in schools and colleges makes the student have more interest in Study. The student of age group 5 to 16 has more interest in the digital study. The basic purpose of teaching is to create interest in students about learning rather than to provide suitable content. The classroom equipped with VR technology allows young students to understand the subject more curiously. A young mind is always curious to learn

and when they are made able to learn to experience real situations, they learn quicker. Teachers can use predeveloped applications that can teach various subjects like Biology, chemistry in 3D animation that provides a clear view to the students and helps them in effective learning. (Babich, 2018.)

The final application of VR in education is for training. VR training provides a safe environment to practice difficult tasks that are dangerous in the real world. VR training has been applied in the field of transportation, medicine, engineering, and the military. Pilots are trained with modern VR flight simulator using real instrument panels to provide real flight experience. Pilot training is costly as well as dangerous therefore VR simulators provide a safe and cheaper alternative to prepare successful pilots who can handle the dangerous situation with safety which is impossible to train real-life situations. The experiments can be done in various weather situations to providing the different virtual climatic conditions. Similarly driving training with lesser risk in the different climatic conditions such as fog or heavy rainfall can be practiced inside a room with no danger of an accident. VR provides a student with a chance of learning by making mistakes with no harm. (Christou, 2010.)

Similarly, training for a medical student is an expensive process and involves risk to the patient. Surgical training is benefitted from Virtual Reality especially haptic technology to feel the sensation of a patient during surgery. Since Virtual Reality provides a multi-user 3D environment it allows the military to have training in the virtual world. (Christou, 2010.)

5.3 Entertainment

The beginning of Virtual Reality happened from the entertainment sector. One of the dense uses of Virtual technology is now being developed for entertainment. Virtual Reality continues to change the world of entertainment with the speed of light. The users can have more personalized entertainment with the development of Virtual Reality. The human mind always seeks new and innovative ways to entertain themselves. Gaming and theatre have been working as the most popular entertaining areas for a long period of time. The presence of Virtual Reality in these two sectors is sure to bring huge success in providing the desired entertainment of every human being. Similarly, music has always a key role in human emotions. Music has the capability to play with human emotions very quickly. Music has the capability to heal human sadness anxiety and provide motivation. VR technology in music can provide access to live music to everyone in the world from a first seat. Likewise, Virtual Reality can take to the

concert happened in the past or bring the dead artist back to the concert. It can still make possible to attend the live concert of Michael Jackson and experience it lively. (Harveston, 2019.)

5.3.1 Gaming

VR was first practiced in gaming and now it has taken the gaming industry to a new height. The biggest application of Virtual Reality in terms of finance is done by Gaming companies. The major factor for the rapid growth of Virtual Reality in the gaming industry is the use of a three-dimensional environment where the player can simulate himself making a part of the game. Virtual Reality in gaming provides spectacular sound and graphics technology with the help of different VR devices such as gloves, headset or glasses. Two factors that make VR games different from other are (Rouse, 2016.)

The technique of detecting the presence of a person moving in a 3D environment with the help of sensors attached to gloves or other VR devices is bio-sensing. For example, a user with a data glove can wear it and use it as driving steering in the racing game. The sensor records the movement of the hand and relates it to the turning of steering of a wheel in a specific direction. (Strickland, 2007)

The Internet has played a vital role in spreading the market of web-based games. Three-dimensional internet allows not just clicking on a link and scanning the information of a webpage rather let the player explore the website in a dynamic way. It allows the user physically to touch that page and manipulate it. (Malewar, 2016.)

5.3.2 Theatre and movies

Theatre and movies are providing entertainment to people for a long time. along with the time, there have been gradual changes in the quality of movies and theatre. A movie theatre was also known as the cinema hall or picture hall has a long history since the beginning of the eighteenth century. Every decade since then to till now the technology has played a significant role in bringing it to the present time. In the present time, 3D and multi-dimensional movies are providing a more realistic feel to the viewer through the beginning of 3d movie that happened around mid-nineties. Virtual Reality has already made its place in the theatre and movies to provide more sensational movies and is gradually rising. Animated movies are taking a huge market in the field of cinemas. Animated movies with Virtual Reality

technology can provide a realistic experience to the viewer without the real cast in the movies. Not just the technology of Virtual Reality but also movies based on the mechanism of Virtual Reality has given big hits in the past. There are few hit movies based on the concept of Virtual Reality such as The Lawnmower Man, Matrix, etc. which are still considered a big hit. (Rubin, 2019.)

The fashion of going to the theatre to watch normal movies has become old. The business of normal theatre is in trouble without the implementation of VR technology. The presence of Virtual Reality can give a new taste to the user when a user can immerse himself in the movie script. Virtual Reality has the potential to allow a viewer to be a part of the script in movies. (Rubin, 2019.)

5.4 Astronomy and Space

It has been very expensive and difficult to put spacecraft into orbit hence the idea of a space elevator is prevailing in the world. The idea of lifting people and equipment out of earth using an elevator seems possible now using the technology of Virtual Reality. The concept is verified in theory its do-able though it can take years to succeed in this idea. (Nield, 2019.)

The technology of Virtual Reality has been assisting to train astronauts in private space companies and space agencies to ground up in space. Virtual Reality has been used as a form of stress management and even pain management which is a very important factor for the astronauts to provide them an easy and comfortable life in space. Virtual Reality helps to eradicate anxiety and maintain the mental health of astronauts. Astronauts can take the experience of space life with the help of Virtual Reality. They can be trained to live in zero gravity and techniques to run their daily life in that situation. Thus, Virtual Reality plays a great role in maintaining mental and physical health in space. (Nield, 2019.)

5.5 Effects of VR to Economy

Virtual Reality is a multi-billion-dollar business that has just stepped in the field of economy. According to Statista, in 2018 4.7 million VR headset were sold worldwide. Sony corporation holds the first place to sell the highest number of headsets which is 4.2 million till march. The huge investment of big

companies like Google, Facebook in Virtual Reality is all set to take the future of this technology to the next level. (Viar360, 2019.)

Virtual Reality has speeded to be part of every sector such as business education science. Virtual Reality has set an enhance economy of every industry. The main reason behind it is the economy. Basically, in fields like game and entertainment sectors, Virtual Reality has brought an economic revolution. Games continue to be a major revenue for Virtual Reality earning 43 percentage of VR's 1.2 billion dollars of software revenue. According to Business Insider Intelligence estimates, it is estimated that the software of Virtual Reality will jump to 587 percentage to 5.5 billion in 2023. (viar360, 2019)Virtual Reality is assisting, on the one hand, to enhance the economy of every sector, on the other hand, itself it is a part of the big economy. The global Virtual Reality in the gaming market is expected to reach approximately USD 14.6 billion by the end of 2023 with 30.5% CAGR during the forecast period 2017-2023. Geographically, North-America holds for the largest market share in the global Virtual Reality in the gaming market, whereas Asia-Pacific is expected to grow at a fast pace over the forecast period, 2017-2023. (marketresearchfuture, 2019.)

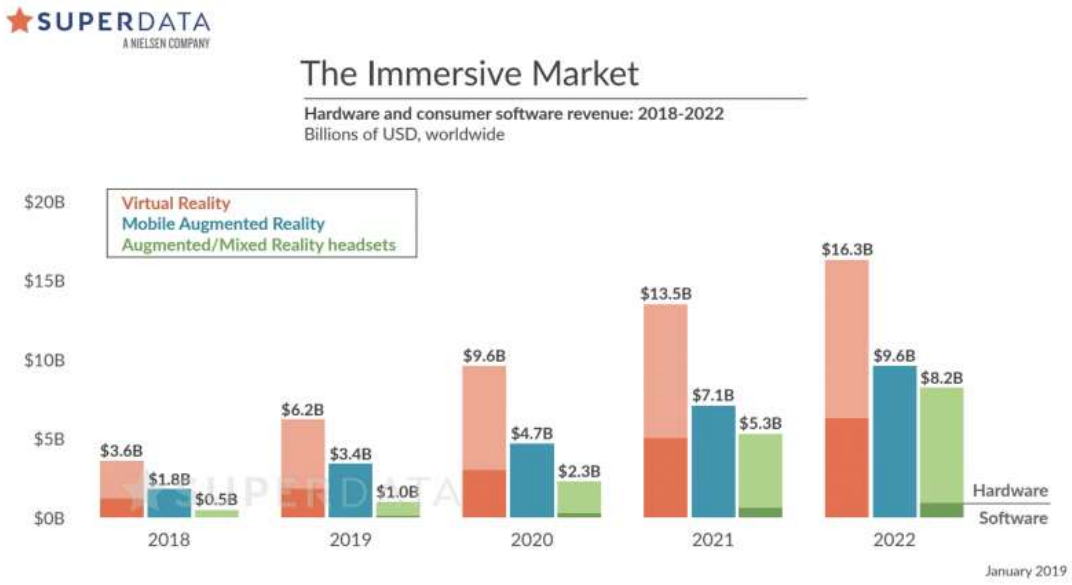


Figure 4: Graph shows AR VR and MR growth from 2018 to 2022 (viar360, 2019)

It is estimated that 171 million people are using VR worldwide in 2019. The majority of products sold are a various range of Head-Mounted Display which is estimated to be above 14 million. According to International Data Corp, the annual growth rate will reach 67% in four years with a shipment of 68.6 million by 2023. The senior vice president of R&D at Sony revealed that they have sold 4.2 million PSVR till the day. Play station VR has a huge room to grow yet because there are 96 million PlayStations

in the market that can provide VR experience. The CEO of Facebook said that sales of Oculus Quest are exceeding the available supply of headset during Facebook's Q2 2019 (viar360, 2019.)

6 NEGATIVE EFFECTS OF VR

Every creation in the world has positive and negative factors. The gradual development of technology certainly has helped to live a human life with comfort and luxury but there are many negative impacts humans are facing because of the same technology. Virtual Reality cannot remain out of this. Technology, on the one hand, is providing great comfort in human life which is considered as development and success in mankind but on other hand is directly or indirectly breaking the law of nature that has a severe effect on a human. Privacy is another issue as VR can immerse someone inside without their consent for experiments. The cost of technology is not such that everyone can afford it. Virtual Reality is an expensive technology. (Dauchot, 2018.)

"Virtual Reality, in order to work well, would have to include the best possible sensing of human activity ever. And it could create practically any experience as a form of feedback. It could turn out to be the evilest invention of all time." (Dauchot, 2018.)

6.1 Health

In 5.1 infinite benefits of Virtual Reality supporting in medical and health are mentioned without any reflection on how it is deteriorating the health of the human and entire natural environment. Virtual Reality is helping to open a new world and do many wonders, but it has a potential threat that can even bring an end to human existence. Technology is providing a great and realistic sensation of an imaginary world. Suppressing the real sense organ, for example, provides a new sight covering up real eyes. This brings a question that has not a world given enough to see, that eyes are needed to be shut to view an imaginary world. Technology has already breakdown the limitation of traveling throughout the galaxy. Similarly covering up ears to hear an artificially created sound. Similar is with taste, the only left sense to experience in VR and the technologist around the globe are working to bring it out soon in the future. The major question is what if people get adapted by this technology. The sense organ may become vestigial or transformed in such a way that they are only compatible to use these devices. If Virtual Reality master in all these senses, it will be difficult to live a life without it. (Lewis, 2018.)

In few last years, several studies found that being immersed in a virtual environment for a long time has a severe effect on the psychology of the human mind. Virtual Reality poses a risk of deteriorating the mental wellbeing of the person. Contents like violence, fight, war are unethical and can lead to the

development of a negative mindset and can cause extreme loss of humanity. Similarly, VR may have a long-lasting traumatic effect outside of the virtual world after experiencing intense emotion in a virtual environment for a long time. “The comprehensive character of VR plus the potential for the global control of experiential content introduces opportunities for new and especially powerful forms of both mental and behavioral manipulation, especially when commercial, political, religious, or governmental interests are behind the creation and maintenance of the virtual worlds.” (Madary and Metzinger, 2016.)

6.1.1 Physical Effects

Motion sickness is a condition resulting after a long-term immersion into the virtual world. The person becomes unaware of things around them. A person can be out of sight and out of mind for a temporary period. People that are prone to motion sickness and vertigo are not going to have a very good experience after returning from the virtual world. Though this varies in individuals if you are prone to unpleasant view it can give a traumatic effect. The person prone to seizure should keep themselves away from this technology because it may invoke a response. However, the average person who doesn’t suffer epileptic condition can experience in the virtual environment. There can be various content in the virtual environment which may be comfortable for every person. Those uncomfortable may lead to nausea. It can be also a result of cybersickness. Cybersickness is very common with these technologies. Physical sickness, eye strain, and poor sight are the result of being long immersed in VR. Just watching tv or phone can result in soreness of the eye. The major reason behind poor vision in young children is because of the constant use of this technology. (Jerald, 2014.)

Cybersickness is explained in New York Time Article as “In traditional motion sickness, the mismatch occurs because you feel movement in the muscles and joints as well as in the intricate coils of the inner ear, but you do not see it. That is why getting up on the deck of a ship and looking at the horizon helps you feel better. But with digital motion sickness, it is the opposite. You see movement — like the turns and twists shown in a movie or video game car chase — that you do not feel. The result is the same: You may have a sensory conflict that can make you feel queasy.” (Lewis, 2018.)

6.2 Societal Impact and Addiction

Technology has broken down the boundaries by distance and made the world smaller and congested but has also created a huge space in humanity and mankind. Machines and computers have suppressed the need for a human to support each other. Entertainment, work, education, research, every filed machine, and computer technology has replaced with the need for human. There is no need for the presence of anyone for entertainment a gaming console can keep a person entertained all day, likewise education and work are replacing humans with technology. What will this lead to in the future is a serious question about the social relationship. Technology while making a better world has certainly failed to keep the balance the law of nature. People are living a more depressed and unhealthy life with the rise of technology that is intended to provide recreation. This kind of technology is causing equally anxiety and depression as a benefit. Technology has deleted or changed the definition of society. It is so that the new generation may not know what society means the way these technologies are making us anti-social. The world after two or three decades faces the problems of overpopulation, extreme unemployment as technology such as Virtual Reality, augmented reality, and artificial intelligence will be capable to do anything. Virtual class virtual teacher, the virtual world will replace the need of real humans in the world. (Koltko-Rivera, 2005.)

While the whole world is in a rush to develop more and more technology with great speed, they are failed to figure out the consequences of their research and invention. As the technology continues to improve and newer applications are discovered there is a question to live a life without the presence of VR. Long term immersion in VR can lead to fatal addiction, dissociation, and fatigue that can lead no control over own body. The result of addiction leads to fatalities and chronic illness. Poor design of content or social interaction that gives a negative message in society can affect the social wellbeing of the person. (Dauchot, 2018.)

7 VIRTUAL REALITY IN FUTURE

There is virtually nothing impossible in VR that is not in real reality. A prediction of the new Virtual Reality world can be made already. Based on today's statistics and the development of Virtual Reality, it will keep behind all world technology that is prevailing now. The future of Virtual Reality looks bright. Sharing space will be one of the novel experiences in the future. The technology of VR and its concept shows that it will minimize the production of hardware in a large amount that is being used in today's technology. Virtual Reality in many sectors has just started and there is a lot more to discover yet. VR in the future is seen as an innovation that will continue to evolve for a long period of time. VR will spread from developed countries all over the world. The cost for the buyers will consistently get lower so that it becomes affordable to everyone. Virtual Reality does not only support the economic sector, but it has a huge potential of changing the way of communication, education, and transportation. Virtual Reality will become the basic need in areas such as Industry and factory. (Rubin, 2019.)

VR has already become affordable and accessible to a big mass already which was not possible a few years ago. The tools to develop VR content are tremendously increasing. A web-based VR can be developed within a couple of hours. The companies are already selling VR Headset in big mass but are still failed to provide to the big mass of people. VR culture is already forming now and getting more popular than ever.

Facebook recently launched a Facebook horizon where users can communicate with each other in a virtual world. Facebook horizon is a virtual social environment where the user can customize their avatar and create and explore their own world. (Constine, 2019.)

The VR technology that has now can cause little physical discomfort to the user as it is mostly the headset. The long use of headset can cause different physical discomfort. In the future, VR will be more comfortable and practical to use. Similarly, a sense of presence will be more realistic and the work of adding a sense of taste will get successful. The future VR will provide a more precise and realistic experience to the user than now.

8 BUILDING AN OPEN VR APPLICATION IN UNITY 3D

Developers have created various platforms to create VR applications using different web-based and machine tools. It is important that a VR developer should have adequate knowledge of the software program before using it. Some developers may find the Unreal engine easier and friendlier because of its features while Unity has been easier for beginners. Basically, the technique and mechanism of working both programs are similar but even a slight change can make a big difference. Since these tools use their standard programming language for coding it's important to have a basic knowledge of relevant programming. The programming language used may differ upon the platform you choose. The thesis includes a process of development of a basic VR application for the Mixed Reality Headset.

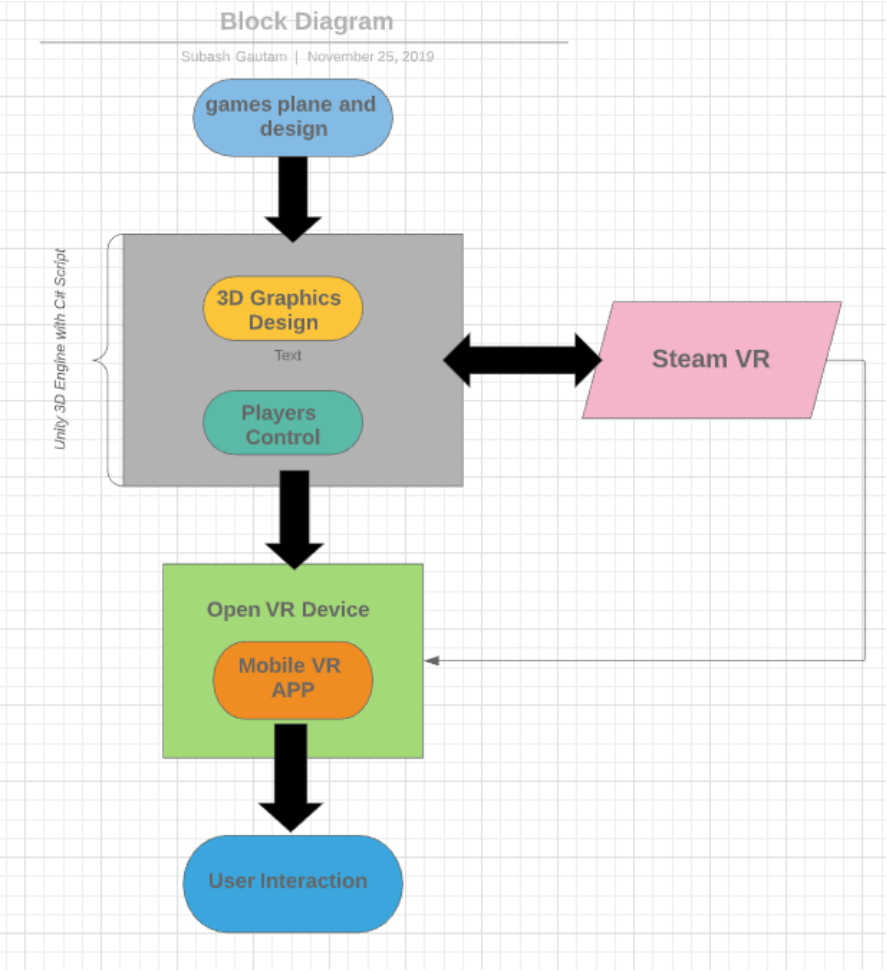
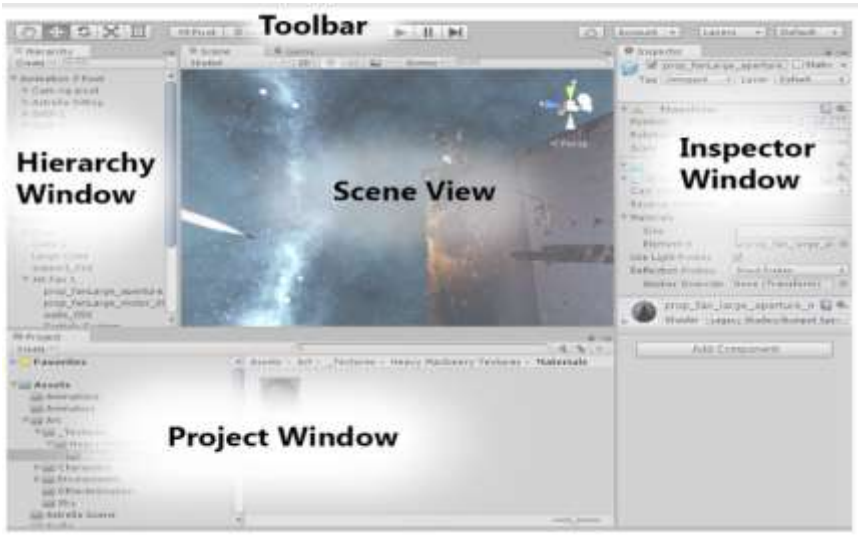


Figure 5: Block diagram of the developed VR game-based application

8.1 Unity 3D

Unity 3D was started as one of the most popular game engines since 2005 and now the most used platform to develop different VR applications. This is one of the most used software programs that is used to develop a 2D and 3D application with high graphic visuals. This is a machine-based software program that can be used in any operating system such as Windows, Mac or Linux. It includes very friendly tools to design an immersive environment for gamers. Unity is a powerful tool for the rapid editing of content and programs. Despite the visual ease of working in Unity, there is a need to understand basic programming skills in either C# or JavaScript in order to write scripts for the various object. Unity uses both JavaScript and C# programming language to code which is directly linked with visual studio. Unity has a very detailed and handy user interface. Because of its rich features such as Physics engine, customized tools, and better collaboration unity has become the most widely used platform for game developers and Mixed Reality developers. Unity supports all kinds of Mixed Reality and Augmented Reality headset. This game engine is free for beginners and to the small companies with less than a hundred thousand dollars annual earning and cost 35 dollars per month for Plus version and 125 dollars per month for the premium version. (Unity, 2019)



Picture 5: Unity3D Default Interface

Talking about Interface of Unity 3D, it consists of four main windows and a Toolbar below its Menu bar. All windows can be rearranged, move from one position to another, maximize, minimize as per the developer's wish. In picture 6 the default interface of Unity 3D has been shown.

The Project Window: All the library of assets such as animation, video, SDKs, etc. required for the project can be copied or just simply dragged in this window. The required assets can be later imported into the project as per requirements. The create option in the top left corner of this window allows you to create several assets required for the project. Similarly, all the scripts, materials or scenes developed are saved in this window.

The Scene View: This is the main window where the project is designed. It allows developers to edit and design the architecture of the project in 2D and 3D. Every character and architecture is designed in this window. Scene Window is switched by Game window when the play button in the tool menu is clicked. The game window can be dragged to side as a separate window so that the developer can test every small change done in the project.

The Hierarchy Window: It displays all the available objects created in the scene in a hierarchical order. The connection between the objects can be viewed, modified or deleted in this window.

The Inspector Window: The characteristics of the object imported or created in the scene window is shown in this Window. The position and properties of every object created or imported can be viewed, emphasized or modified in this Window.

8.2 Requirements

Before beginning any VR project every developer should know about the requirements of the tools to develop their project. First and foremost, the latest version of Unity has required that support the latest VR device and provide an advanced tool for the development of any VR content. For the thesis project, the latest version of Unity i.e. 2019.2.9f1 of 64-bit has been used. It is very important to use the most upgraded version of Unity as they are upgraded with advanced features very often. The preparation of raw material for the development of any project is equally important. Unity provides a lot of tools to develop content for a VR project, but it is certainly not enough to design every VR content. Unity provides tools to design basic 3D structures such as sphere cylinder cubes. For advance 3d design a developer should use different tools such as Blender and 3D MAX.

Different hardware devices have different tools and SDK requirements. In the case of any VR application development, it is important to understand the set-up process to make sure firmware, runtime, and

hardware are correctly configured. System requirements of many VR devices such as Oculus no longer support 32-bit apps so the application should be built on a 64-bit system.

On the basis of the VR device that is being used for the project, it is important to choose the most suitable version of Unity. Since this project in the thesis is using Oculus, one of the following versions of unity is recommended for all kind of Oculus development on today's date
2017.4.28 LTS or above

2018.4 LTS

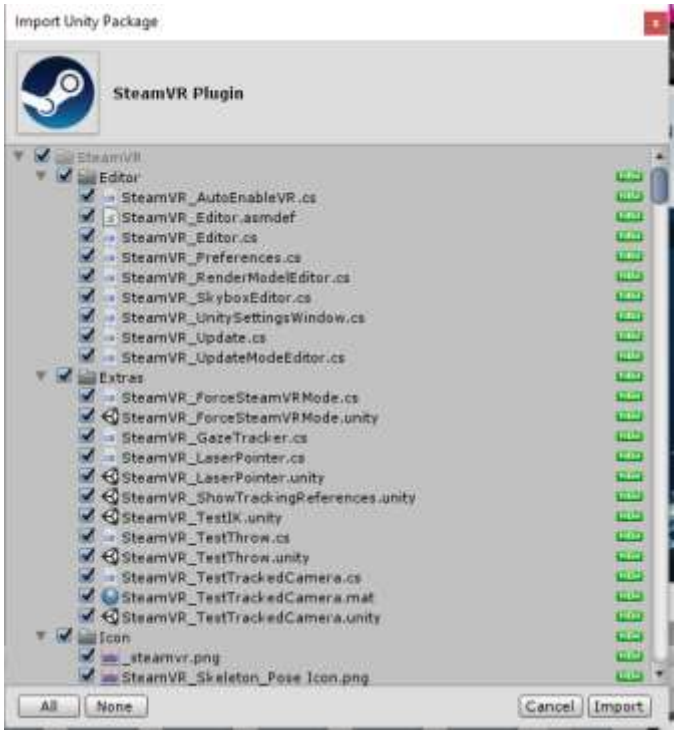
2019.1.2f1 (which is being used in this project) or above

The minimum supported version for Oculus development in Unity Editor Version 2017.4.11f1.

The complete development of a virtual environment requires resources. Unity as a tool is not enough to fulfill all kinds of requirements but it has a great medium to import other externally created resources and tools.

Unity Assets: Unity has its own asset store which is home to thousands of free or cheap assets required for the development of a project. The store contains various assets such as 3D textures, animation, tutorials, and editor extension. It not only saves the time of a Unity creator but also provides the learning materials and important SDKs required for the operation of a project. Assets can be easily accessed via Unity 3D and imported all assets into the project. To access the store in the project, go to Windows > Asset Store.

SteamVR Plugin: A set of tools has been published by Valve in the Unity store that allows developers to access functionality for their OpenVR devices is known as SteamVR Plugin. It is a complete package to generate common VR experiences such as hand interactions and teleportation. The latest version of SteamVR Unity Plugin manages the 3D models for VR controllers, maintains input from the controllers and gives an estimation of the correct angular view. This project has been created using Unity 2019.1.2f1 and SteamVR 2.5.0(sdk1.8.19) for an open VR device. SteamVR Plugin can be easily downloaded from the Unity asset store and should be imported to the project. The latest version of SteamVR in this project also provides the configurations for input.



Picture 6: SteamVR Plugin from the Unity Asset Store

8.3 Game Design

In general, the application development procedure in Unity 3D can be divided into major categories first, importing or creating character or player in the scene window and scripting for the functionality of the character. Adding physics, modifying and positioning different objects and creating a required component for the project is done in the Inspector Window. Every object created in the scene window is referenced to a script coded in the code editor.

8.3.1 Graphical Design

For this project, three objects a Player Cube, a Ground and many smaller cubes as Obstacle has been created as shown in Table 1 below

Table1: Design of cubes

Cubes	x	y	z	Mass	Color
Ground	15	1	10000	null	White
Player	1	1	1	1	Red

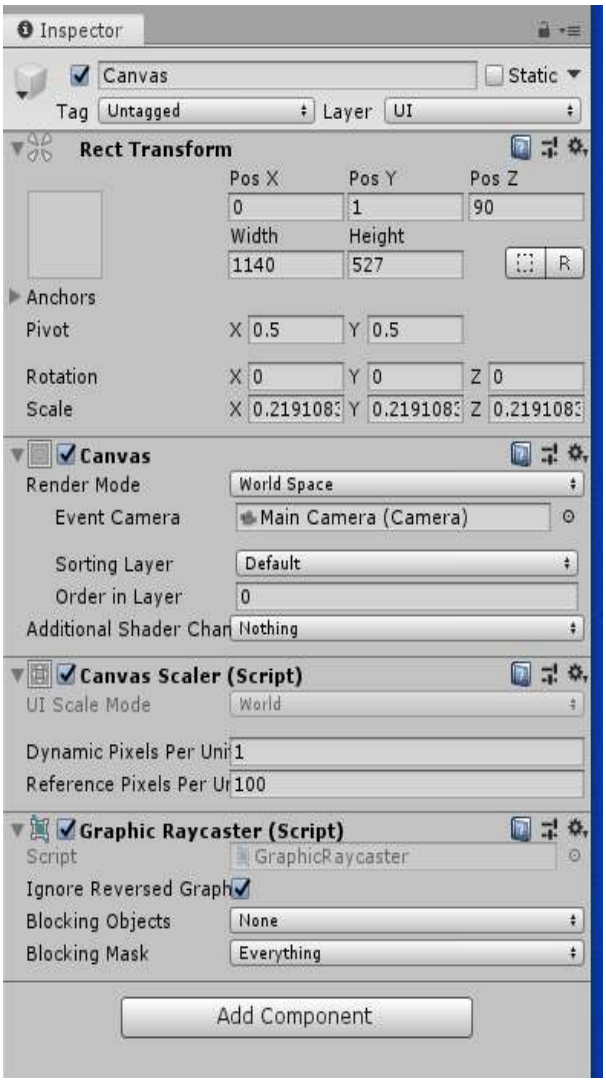
Obstacle	2	1	1	2	Grey

Table 2: Position of the Game Object

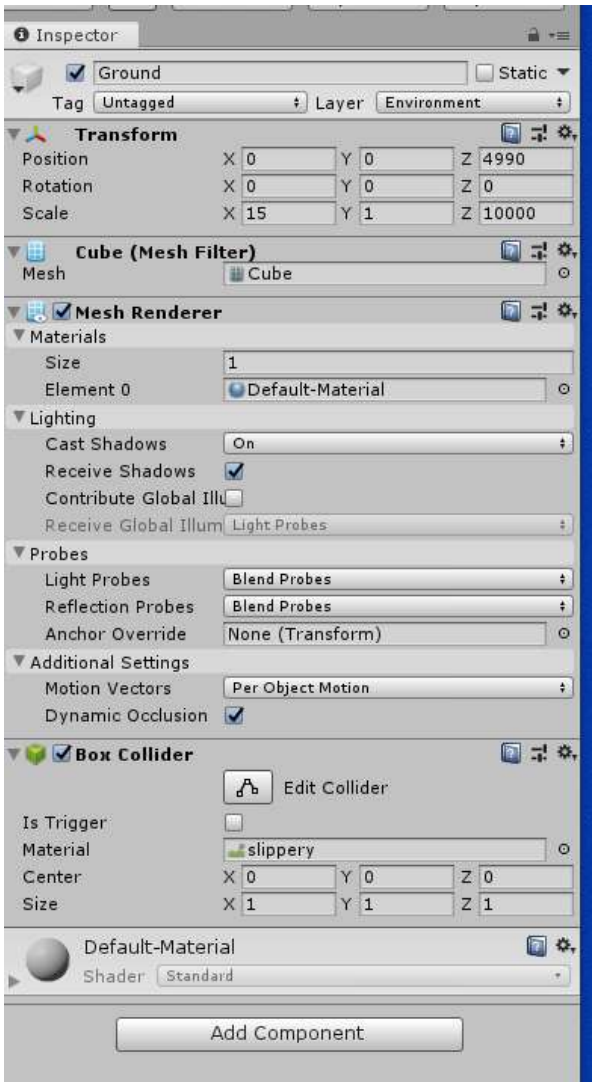
Position	x	y	z
Ground	0	0	4990
Camera	0	1	-5
Light Direction	0	3	0

In table 1 the dimension, mass, and color of the object created in this project are mentioned. Figure 7 shows the basic design of this game. For the ground, a cube has been expanded in the x-axis and z-axis to create a long platform for the placement of obstacles and payer cube on it.

The position of the ground, camera, and direction of light are equally important as creating objects to provide a realistic immersion to the user. The ground is positioned to a stationary level in a different dimension as shown in table 2. Similarly, camera and light direction are also well positioned in a different dimension as shown in table 2 for a better and realistic view of the environment. The camera is positioned slightly backward whereas light direction comes from slightly high. This is saved in the project window as scene one.



Picture 7: Menu UI Design



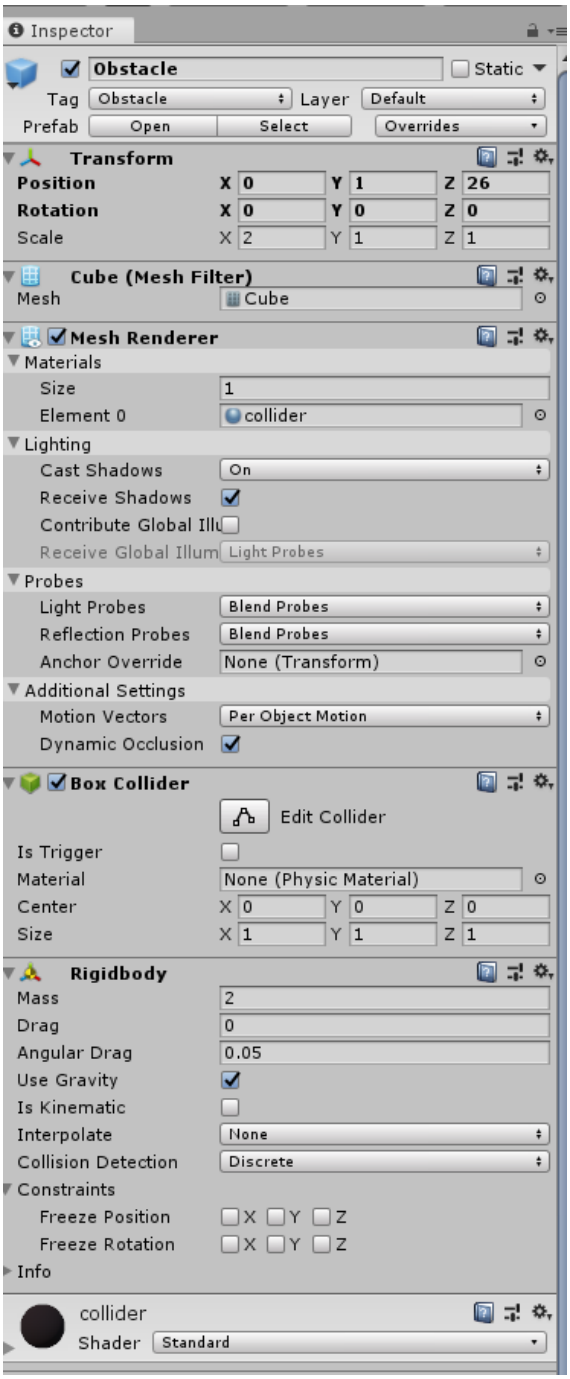
Picture 8: Ground Design

In figure 7 and 8, all the physical properties and geometry implemented to the object ground and canvas are shown. A physics material called slippery is created and implemented in the ground to provide the smooth movement of the player cube. The implementation of slippery material into the ground prevents the player cube from rolling and provide a stationary movement. The ground is a stationary object which is positioned as shown in Table 2 above.

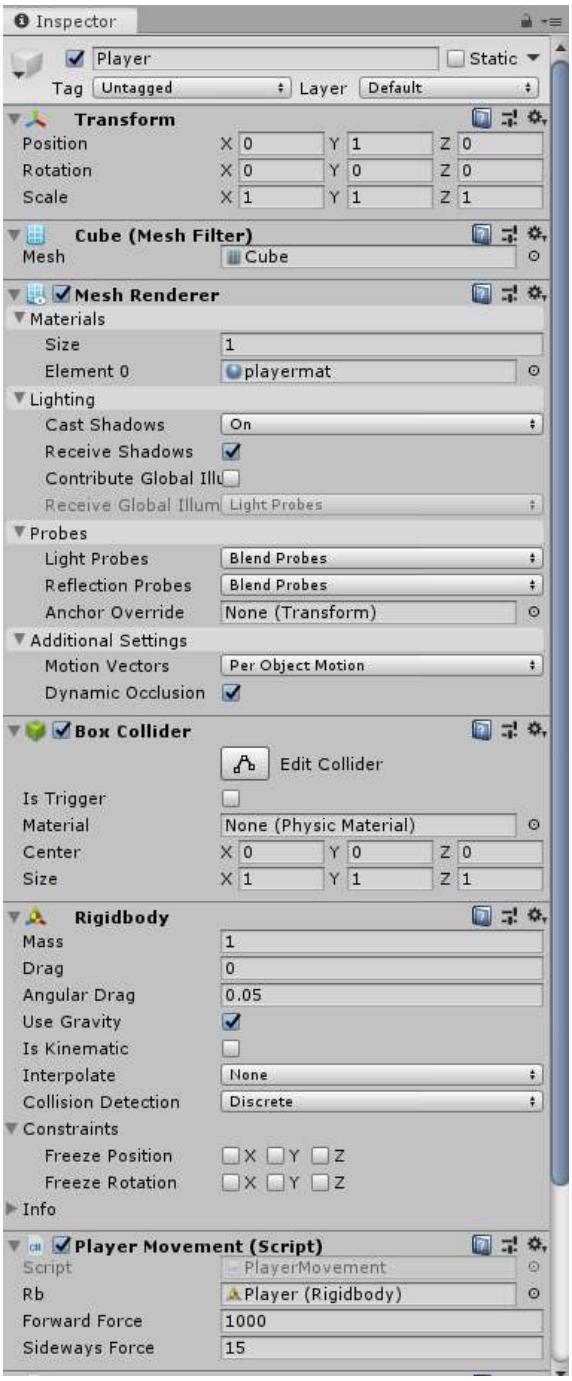
Similarly, Player cube and Obstacles are created with the mentioned dimension, mass, and color as shown in Table 1. Player cube and Obstacle are implemented with box collider and rigid body properties which provides a realistic physical view when the player cube collides with the obstacle cube. The reason for the bigger mass of obstacle cube is also to provide stationary movement after the collision.

Picture 9: Canvas UI

Similarly, a new scene named as welcome is created as the menu UI of the game which is followed by the scene one. In this scene, the 2D canvas is created which consists of a text and a PLAY button. The position size and position of canvas along with its component is displayed in the game windows as shown in Picture 9. This is the first window when the game is launched where the Play button can be teleported by the controller and the scene one window appears where the game starts.



Picture 10: Design and Properties of Obstacle



Picture 11: Design and Properties of Player

Physical properties such as Mesh Render, Rigidbody, Box collider are applied in the game objects as shown in Picture 10 and 11. The implementation of Mesh Render in a game object provides a solid 3D view. Rigidbody is implemented to receive force and torque in order to make the realistic movement of the game object. Likewise, Box collider implementation in any game object provides the realistic movement of objects after the collision. Physics such as gravity plays an important role in maintaining all these properties.

8.3.2 Scripting

Scripting is essential for the proper functioning of a designed object in unity. The script is also used to create graphical effects, to implement the desired control in the physical behavior of any object. Basically, unity supports two programming language C# and JavaScript and in addition many other .NET languages. However, C# is the most widely used for creating a game and Virtual Reality development. Visual studio has been used as a platform for coding as it can be directly linked with the Unity.

The objects created in the project is controlled by the components that are referenced with them. Unity allows to develop their own component and attach them to the game object. Creating a C# script is simple and is created in the project window by selecting assets>create>C# script. There are multiple ways of doing the same thing in Unity. Another way you can simply go to Add a component in the Inspector window and choose the new script and create a new C# script. Thus, created C# script file is stored in the project panel which is when double-clicked to open in the visual studio for a window user. In the visual studio, C# is already provided with void Start and void Update function.

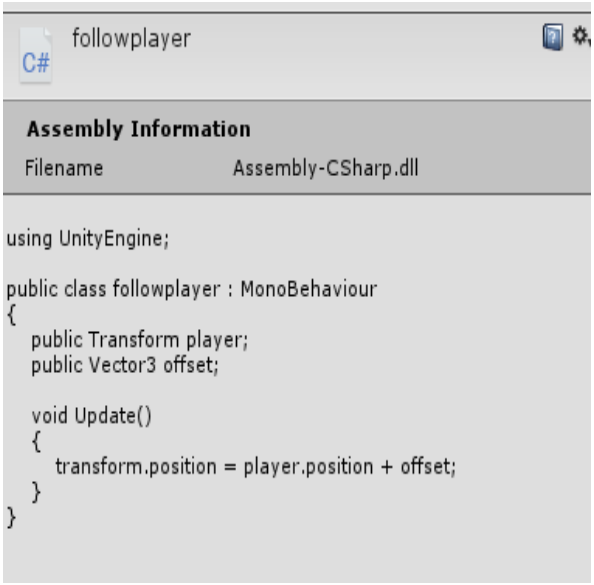


Figure 6: FollowPlayer

In figure 5 above another C# script is created named Followplayer which makes the camera follow the player cube. There are multiple ways of doing and the one easy way is dragging the main camera into the player cube. This process is called parenting in Unity. However, in this project, a separate script has

been developed for the smooth follow of the camera which only moves with the position of the player cube. To have a smooth view while playing, the camera has been positioned slightly behind and higher from the position of the player cube.

PlayerMovement

Assembly Information

Filename Assembly-CSharp.dll

```
using UnityEngine;

public class PlayerMovement : MonoBehaviour
{
    public Rigidbody rb;
    public float forwardForce = 2000f;
    public float sidewaysForce = 500f;


    void FixedUpdate()
    {
        rb.AddForce(0, 0, forwardForce * Time.deltaTime);

        transform.Translate(Input.GetAxis("Horizontal") *
Time.deltaTime * sidewaysForce, 0, 0);
    }
}
```

Figure 7: PlayerMovement

In figure 6, A C# script named as PlayerMovement is created for the Player cube. In the script, the Rigidbody component is modified to add some constant force in the game in order to move the object player constantly. Similarly, the player cube is also scripted to move horizontally with a certain force in X-axis by the controller. The movement speed is scripted to be adjusted in the inspector window.

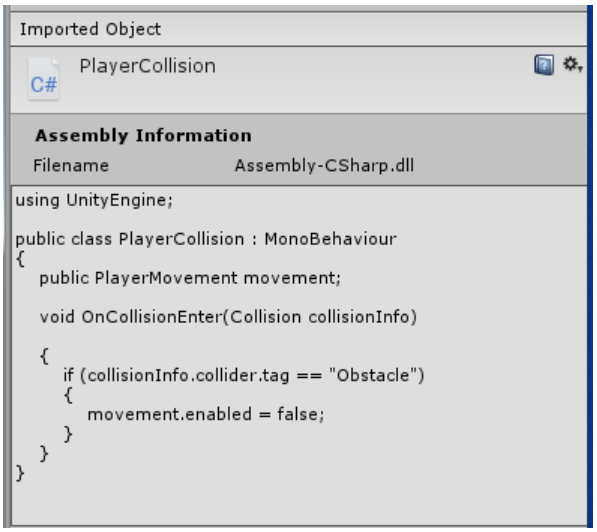


Figure 8: PlayerCollision

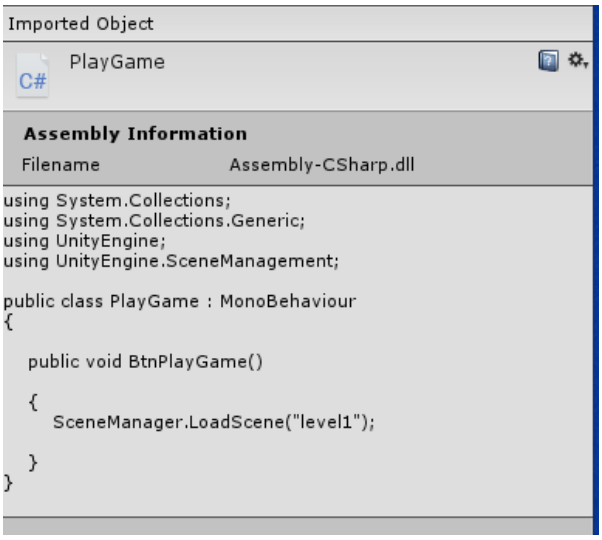


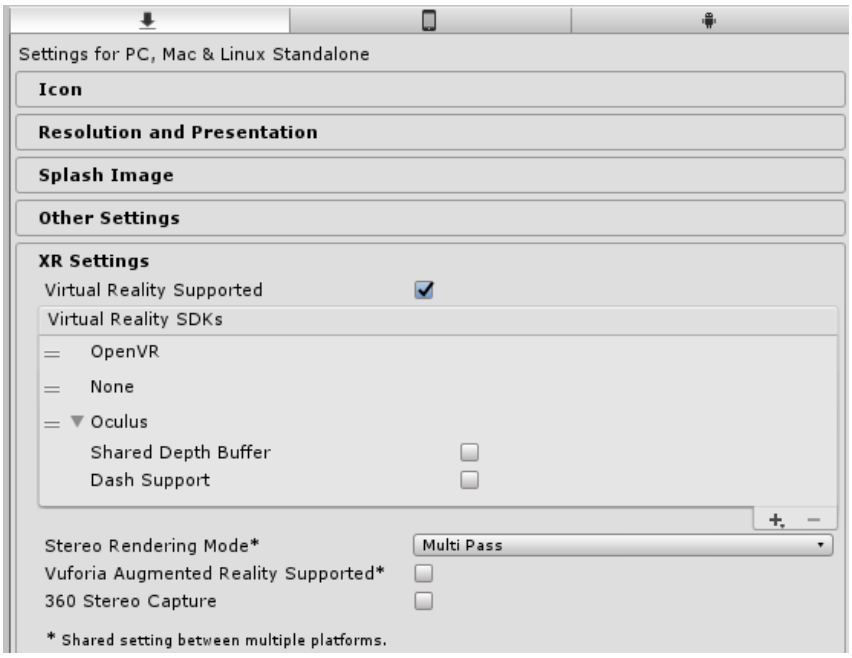
Figure 9: PlayGame

In Figure 7 another script named PlayerCollison is created to generate the collision effect between the cube. When player cube collides with the Obstacle it gives the physical effect as any rigid body would collide. In the last, a script called PlayGame as shown in Figure 8 is created which only helps to switch the scene from the window scene to level 1 scene.

Figure 10: Result in the Game window

In figure 9, the final look of this game in the game window of Unity is shown. The game was played by many students at an event in the school using a Mixed Reality Headset and a controller.

Unity allows you to choose a VR device for the project that has been developed. Since this project has been developed for OpenVR, a mixed reality headset has been used. Every VR device has its own SDK in the Unity asset store which makes it easier to develop a project for the desired device. Unity allows VR device to run a project only after enabling the Virtual Reality supported. These settings can be changed from Edit>Project Settings>Player>XR Settings as shown in Picture 12 below. VR project for android and IOS can be also created from the Player Settings.



Picture 12: XR Setting for suitable VR device

8.4 Keys for best VR performance

While going through the development process of any VR applications there can come many mysterious problems. Occasionally even though the applications are well-scripted and well designed the result may not come as expected. Taking care of minor things during the development of any project is important to avoid such problems. Positioning the game object such as the camera and the light direction in the required dimension gives a required view of the application. Proper lighting settings which can be done via Edit>Rendering>Lightning setting helps in generating a clear view. While scripting in Visual Studio unwanted lines of code can be removed. Editing the project in play mode doesn't bring change in the application. Importing only required assets and libraries in the project panel, upgrading graphics driver and OS are other factors that are important to be considered during the development of an application.

9 CONCLUSION

The goal of this thesis is to enlighten what kind of impact this fast-growing technology especially Virtual Reality brings to humans. The thesis has been started with the definition of Virtual Reality and explained the impact of these technologies at the present situation and in the future. How Virtual Reality is assisting in different sectors of health, education, entertainment and what kind of consequences are there along with the development of many sectors by the help of these kinds of technology is clarified in the thesis. The thesis includes topics such as components, history, advantages and disadvantages of virtual and future of Virtual Reality. Generally, the importance and benefits of the technology are presented everywhere but many articles failed to assemble the negative impact of these technologies. I have tried to cover the limitation of many reports in this thesis.

The thesis also includes the development process of a simple Open Virtual Reality Game in Unity 3D. The tools and programming that can be used in the development of a basic game are mentioned. It is believed that a reader can design a basic game in Unity 3D reading this report. All the important keys required for the basic development of a basic VR game is explained in this thesis. The game is not completely built yet as it lacks the proper UI and sound system. The addition of animation, audio, and more levels are being developed. The game is built using the C# programming language. The game was played by many students at an event in the school using the mixed reality headset and a controller.

This thesis has focused on providing an overview of VR and explained the most important elements of VR. The field of VR and its application has no limit to conclude everything in this thesis but however, the reader can get basic ideas about Virtual Reality. It varies in the opinion of individuals and how they make use of Virtual Reality in their life. Technologies such as VR hold unlimited possibilities in scientific research and invention.

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